

The Tritium Storage and Assay System stores tritium in a safe hydride form and transfers tritium gas for experimental needs.



Safety and Tritium Applied Research Facility

A unique capability for advancing tritium and fusion nuclear sciences

Fusion power promises an energy source with abundant fuel that does not produce greenhouse gases nor long-lived radioactive waste. Tritium, the radioactive isotope of hydrogen, makes up 50% of the fuel in deuterium-tritium fusion reactions, and it needs to be safely contained within fusion facilities in order to provide environmentally benign and safe fusion power.

The amount of tritium retained and permeating through a vessel determine the source terms for the inventory inside and released from a vessel in reactor safety assessments for licensing fusion facilities. Because deuterium-tritium fusion reactions produce 14 MeV fast neutrons that create radiation-induced damages in fusion material, tritium behavior in a nuclear

environment needs to be understood to enable accurate predictions of tritium transport behavior in fusion materials.

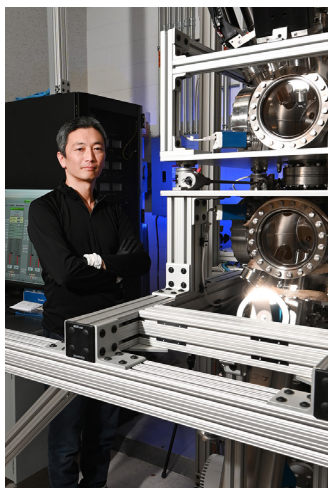
FACILITY DETAILS

The Safety and Tritium Applied Research (STAR) facility is a Department of Energy (DOE) Below Hazard Category 3 nuclear facility at Idaho National Laboratory's Advanced Test Reactor Complex. This facility advances tritium and fusion nuclear sciences. The work supports the DOE Office of Science Fusion Energy Sciences, Office of Nuclear Energy Advanced Reactor Demonstration Program, Molten Salt Reactor programs and others (e.g. Laboratory Directed Research and Development, Advanced Research Projects Agency-Energy, National Nuclear Security Administration, National Aeronautics and Space Administration).

The 4,000-square-foot tritium facility incorporates various experiments to identify the potential risks and hazards associated with tritium retention and permeation in fusion material, as well as the development of technologies to minimize the environmental impacts of fusion energy. The STAR facility plays an important role in advancing the technologies needed to make fusion energy safe. It also supports private sector fusion research with unique experimental capabilities. STAR researchers aim to accelerate fusion technology with a focus on issues related to tritium and radioactive material.

FACILITY CAPABILITIES

- Handling tritium (up to 1.6 grams, ~15,390 Ci) and low-level activated material (typically < 100 mrem/hour at 30 cm).



The Permeation Experiment for Asymmetric Surfaces was developed for hydrogen separation applications.

- Using inert-gas gloveboxes and/or ventilated enclosures to contain tritium, beryllium and lead.
 - Tritium: radioisotope of hydrogen, fuel for fusion reactors and undesired byproduct in some fission reactors.
- Beryllium: a toxic metal that is used as a neutron reflector/multiplier in fission & fusion systems, and fusion first wall materials.
- Lead: a toxic metal that is used as a neutron multiplier in fusion systems.
- Lithium: a highly reactive metal that is used to breed tritium in fusion systems
- Performing diagnostics for tritium-exposed, low-level neutron activated materials.

Key Capabilities

Tritium Plasma Experiment	Exposes plasma-facing component materials to fusion divertor-relevant high-flux deuterium/tritium/helium plasma for plasma-material interaction study.
Tritium Gas Absorption Permeation System	Measures the diffusivity, solubility and permeability of tritium in nuclear materials.
Static Gas Absorption Permeation System	Measures absorption rate, diffusivity, solubility and permeability of hydrogen and deuterium in nuclear materials.
Permeation Experiment for Asymmetric Surfaces System	Characterizes the material evolution in membranes (e.g., surface chemistry, material interdiffusion) for hydrogen separation applications.
Tritium Extraction Experiment	A forced-convection lead-lithium loop for testing and advancing the extraction efficiency of tritium from fusion liquid breeding material.
Tritium Storage and Assay System	Stores up to 1.6 grams of tritium in a safe hydride form and transfers tritium gas for experimental needs.

FOR MORE INFORMATION

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Diagnostic capabilities for tritium-exposed and low-activation materials

Thermal Desorption Spectroscopy	Measures total amount of hydrogen/deuterium/ helium from bulk materials.
Coincidence Doppler Broadening and Lifetime Positron Annihilation Spectroscopy	Measures type, size and density of radiation-induced defects in bulk nuclear materials.
X-Ray Photoelectron Spectroscopy—Perkin-Elmer PHI 5100	Characterizes surface chemistry on material surfaces.
Scanning Auger Microscope—Perkin-Elmer PHI 660	Measures two-dimensional surface composition on material surfaces.
Glow Discharge Optical Emission Spectroscopy—Horiba Profiler 2	Measures depth profiles of material composition up to 100 microns in materials.
Confocal Laser Scanning Microscope—Keyence VK-X250	Quantifies three-dimensional surface morphology and surface roughness.
Digital Microscope with Laser-Induced Breakdown Spectroscopy—Keyence VHK7000 with EA-300	Identifies material composition directly from digital microscope.

Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy.